Appendix K

M93 Chronograph Muzzle Velocity System

This appendix describes the M93 chronograph MVS operations and procedures for calibrating or updating current MVVs for the COS, POC, and platoon leadership per TM 9-2350-314-10.

GENERAL DESCRIPTION

K-1. The MVS is a MV measurement system, which operates on the Doppler principle. The system is based on a X-band transceiver and a MV processor. The purpose of the M93 MVS is to provide an accurate MV reading for a projectile fired from the howitzer. The M93 MVS is designed to communicate measured projectile velocities via a military standard-1533 data bus to the AFCS. This information can be used to provide a reasonable estimate of the average MV for rounds to be fired for a new fire mission; thereby improving the possibility of a first round hit on the target.

K-2. The MVS consists of the following components (Figure K-1):

- M93 radar antenna transceiver.
- W92 power/data cable.
- Mounting bracket with 1553 bus terminator and storage connector.
- W93 (1553 bus) cable assembly (connects MVS to AFCS).

K-3. When not in use, the MVS can remain installed on the howitzer. If the MVS is not mounted on the howitzer, ensure that the termination connector is installed on the wiring harness W93 connector at the MVS mounting bracket. If the MVS must be stored it will be IAW TM 9-2350-314-10. The MVS must be re-installed prior to turning on the vehicle master switch.

ENVIRONMENTAL INFORMATION

K-4. The M93 MVS is designed to withstand adverse conditions, which may be present during storage and operation. The M93 MVS will function properly without degradation under the following conditions:

- Operating temperatures from –50 to +125 degrees Fahrenheit.
- Storage temperatures from –50 to +150 degrees Fahrenheit.
- 0 to 95 percent relative humidity, including condensation.
- Shocks and vibrations present during firing and transport.
- High altitude during air transport.
- Rain, wind, sand, and dust.
- Solar radiation (direct sunlight).
- Salt and fog.
- Environments leading to growth of fungus.

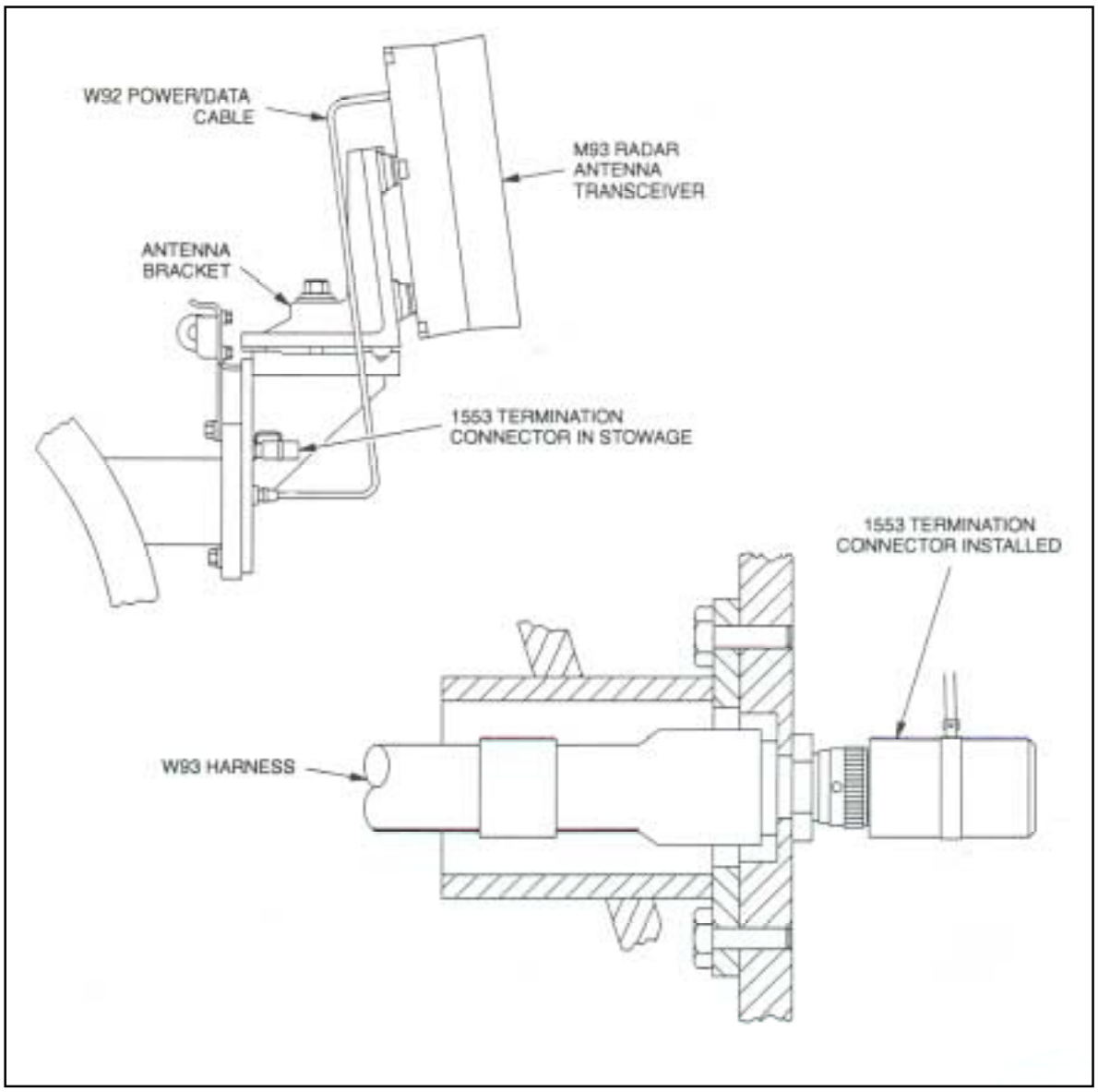

Figure K-1. M93 Muzzle Velocity System

INSTALLATION

13B COS

K-5. Note: The MVS should be installed before all missions and must be connected prior to AFCS initialization.

- Insure vehicle master power switch is in the "off" position.
- Inspect M93 radar antenna head for any damage. Install antenna bracket on mounting bracket.
- Remove 1553 bus terminator from W93 cable connector and connect to the storage connector.

- Inspect all connectors for bent pins.
- Ensure proper cable connections. Inspect W92 cable to M93 radar antenna and W93 cable connector.

OPERATIONAL SEQUENCE

COS DUTIES

- Power up the AFCS.
- Check AFCS status.
- Initialize AFCS.
- Enter extended propellant lots. (Note: To use the MVS, you must have an extended propellant lot code in the AFCS ammunition inventory.)
- Enter minimum number of rounds for MVV calculation as directed by the TSOP.
- Prepare for POC BCS to send fire missions digitally.

K-6. Note: The AFCS will calculate a solution; the AFCS will report a MVV to the POC if certain requirements are met:

- AFCS processing a new MVV.
- Deletion of a MVV.
- +/- 2 meters per second change from previous MVV.

K-7. The AFCS must detect readings within +/- 100 meters per second from standard. Additionally, the AFCS will not generate a MVV unless the "MVV ROUND" entry has been met or exceeded. The AFCS sends the MVV automatically to the POC BCS. Once the AFCS receives acknowledgment from the BCS the system will apply the new MVV to the database.

TROUBLESHOOTING

MVS NOT DETECTED DURING AFCS POWER UP

K-8. Power up status screen shows two dash marks (--) in status column.

Procedures

K-9. **First.**

- Check that MVS radar antenna is installed correctly.
- Check W92 cable connections at MVS antenna and at the W93 cable connector
- Check W92 cable for damage.

K-10. **Second.**

- Power down AFCS by ensuring the DU power switch is placed in the "off" position.
- Ensure the vehicle master power switch is in the "off" position.
- Disconnect W92 cable and check for bent or broken pins or damage to connectors.
- Connect 1553 termination connector to the W93 harness.
- Start operational sequence power up status for MVS is "OK".
- Power down completely.

- Reconnect W92 cable and recycle power. If problem exists notify unit maintenance.
- Start operational sequence. If problem exists notify unit maintenance.

NO MVV ACQUIRED

- Step 1. Was "EOM" sent to the AFCS?
- Step 2. Was the "MVV ROUNDS" set to the minimum required?
- Step 3. Was the required minimum number of rounds fired?
- Step 4. Did the AFCS use the same type of ammunition combination and quantity required by the BCS for the fire mission?
- Step 5. Check last mission data to verify if reading was taken.

MVS DECREMENTS ROUNDS PREMATURELY WHEN BREECH IS CLOSED

- When this occurs, no useful MVV data can be gathered.
- Request guidance from POC regarding completion of fire mission.
- Turn in MVS to unit maintenance for repair/replacement.

STEP BY STEP PROCEDURES FOR CALIBRATION

K-11. Note: Before powering up the howitzer, inspect and connect the M93 MVS cables and head.

- Initialize the AFCS at a SCP.
- Receive a move order to a firing area and perform occupation procedures.
- Do a navigation update at a SCP (if necessary)
- Receive BCS PROVIDED AMMO from POC (one time only).
- Enter/verify extended lot for propellant.
- Set MVV ROUNDS as directed.
- Enter current propellant temperature.
- POC will request MVVs from AFCS (transparent to operator).
- From SET UP AND INFORMATION menu, select AFCS STATUS and ensure MVS is operational.
- From MAINTENANCE menu, select BORESIGHT entry and verify the AZ offset, roll offset, and the elevation offset against the DA Form 2408-4 Weapon Record Data (platoon sergeant is responsible for checking this data).
- Ensure borescope and pullover has been performed.
- Ensure a minimum of 50 meters between guns.
- Once everything is verified, conduct fire missions. (POC sends a WHEN READY digital fire mission).
- To view the MV acquired on the AFCS, EOM must first be sent. At EOM go to SETUP AND INFORMATION menu. Select MUZZLE VELOCITY and then select VIEW LAST MISSION DATA.

K-12. **Note:** For a more accurate MVV, ensure the tube is warm or a warm up round has been fired.

PLATOON LEADERSHIP ACTIONS

K-13. The following is a checklist (Table K-1) that assists the platoon leadership in obtaining MVs. It is imperative that each of the steps be followed to allow for greater probability of obtaining usable MVs whether at a dedicated calibration site or updating MVVs during a live firing exercise.

Table K-1. Muzzle Velocity Checklist

PLATOON	GUN 1	GUN 2	GUN 3
M93 CONNECTED (PRIOR TO POWER UP)			
NAV POSITION UPDATE (VERIFY PLGR FIGURE OF MERIT 1)			
ROUNDS, FUZES (BCS PROVIDES), VERIFY			
POWDER TEMPERATURE			
MVV ROUNDS (1-9) (UNIT TSOP)			
SELECT AFCS STATUS AND ENSURE MVS IS OPERATIONAL			
BORESIGHT ENTRY			
VERIFICATION MISSION			

POC RESPONSIBILITIES

K-14. The POC's main responsibility during the operation of the M93 is to verify and record all information reported from the AFCS. The POC will verify that communication is established by requesting MVVs from the AFCS. There are different methods for obtaining MVVs from the AFCS. The POC FDC chief and/or FDO must decide the preferred method:

INITIAL CALIBRATION (NO PREVIOUS MVVs RECORDED)

- Ensure MVVs are deleted from the AFCS.
- Gun must delete by date time group, projectile, and propellant lot.
- POC will request MVVs from howitzer to verify deletion.
- Delete MVVs in POC database.

Note. To ensure that the AFCS has no MVVs, the POC can send a MVV table to the AFCS with a non-existing shell/fuze combination set with a MVV reading of 0.0. A blank table cannot be sent to the AFCS. (There must be at least one entry in the MVV table.)

PREVIOUS MVVs ALREADY RECORDED AND DESIRED LOT TO MEASURE HAS NO MVV

- Verify previous MVVs on AFCS and BCS with recorded historical data.

- Verify lot has no previous MVV in AFCS and LCU database based on AFCS ammunition entered.

PREVIOUS MVVs ALREADY RECORDED AND DESIRED LOT TO MEASURE HAS PREVIOUS MVV

- Verify previous MVVs on AFCS and BCS with recorded historical data.

Note: A new MVV will not be generated unless there is a change of +/- 2.0 meters per second from recorded MVV.

K-15. The POC will then send BCS provided AMMO (if not already done). Once AFCS has received the AMMO and the operator has had time to execute, the POC will request AMMO to verify it has been received. The POC will then verify that the AFCS has extended lot designators and the MVS round count has been set to appropriate setting. The POC is now ready to send a mission with the appropriate round count.

K-16. Upon EOM the AFCS will send a MVV as long as certain requirements are met:

- AFCS calculates a new MVV
- Change in 2 meters per second from previously recorded MVV.

K-17. Once the AFCS receives an acknowledgment from the BCS, the MVV will be stored. If there is no acknowledgement from the BCS the MVV will not be stored on the AFCS. Once the BCS receives the MVV in the INPUT queue, the MVV should be displayed and verified by the FDC chief and FDO. Once the MVV has been verified the LCU operator will execute the MVV and the FDO will record it. The POC will request the MVV from the AFCS to verify proper MVV and will conduct a verification mission

K-18. Note: A MVV that is stored on the AFCS will be applied to other MVVs from 3 charges up to 3 charges down, as long as there are no MVVs for that shell/propellant combination. (e.g., If charge 6W HEA has recorded MVVs and a charge 5W HEA is being shot with no MVVs, the AFCS will apply the charge 6W to the 5W to get the most accurate data. If all requirements are met with the MVS a MVV for the 5w should be generated and sent to the POC.)

K-19. The POC M93 operation checklist is provided at Table K-2. For troubleshooting procedures for faults found, refer to Table K-3.

Table K-2. POC M93 Operation Checklist

PROCEDURE	COMPLETED
VERIFY COMMUNICATIONS	
VERIFY MVVs ON AFCS AND BCS DATABASE ARE CURRENT	
SEND BCS PROVIDED TO AFCS	
VERIFY EXTENDED LOT DESIGNATORS IN AFCS	
VERIFY MVS ROUND COUNT IN AFCS BY VOICE	
SEND MISSION WITH APPROPRIATE ROUND COUNT	
VERIFY MVV RECEIVED FROM AFCS (FDC CHIEF AND FDO)	
PROCESS MVV (EXECUTE)	
RECORD MVV	
VERIFICATION MISSION	

Table K-3. POC M93 Operation Troubleshooting Procedures

VERIFY COMMUNICATIONS	Verify initialization parameters in AFCS and LCU database. Verify radio frequencies and setting. Try voice on digital radio.
VERIFY MVVs IN DATABASE IN AFCS AND LCU	Verify that all MVVs are current from previously recorded MVVs (MVV book).
SEND BCS PROVIDED TO AFCS	Verify lots sent to gun are correct and match ammunition inventory.
VERIFY EXTENDED LOT DESIGNATORS IN AFCS	Request MVVs from AFCS and verify extended lot designators.
VERIFY MVS ROUND COUNT IN AFCS	Make sure that MVS round count is equal to or greater than the mission fired count.
SEND MISSION WITH APPROPRIATE ROUND COUNT	If mission does not have appropriate rounds a MVV will not be generated.
VERIFY MVV RECEIVED FROM AFCS (FDCCHIEF AND FDO)	Verify that MVV received is accurate. If the MVV is invalid, then delete the MVV by propellant lot from the AFCS.
RECORD MVV	The battalion and batteries should keep a detailed record of all MVVs for each weapon.